Geophysical Research Abstracts, Vol. 7, 06337, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06337

Mapping the probability of shallow landslides and channelised debris flows with a coupled hydrological-geotechnical distributed model

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We cannot currently predict the triggering of shallow landslides which eventually turn into a debris or a mudflow in channeled areas. These phenomena in fact depend in a complex manner upon initial and boundary conditions and are affected by heterogeneity in soil hydraulic and geotechnical properties, landscape structural and geological properties, soil moisture profile and surface–subsurface interactions. In this work we try to map and treat these phenomena coupling a hydrological distributed model, GEOtop and an infinite-slope geotechnical model, SF. The combined model, GEOtop-SF, allows both the hydraulic and geotechnical properties of the soil to be considered and physically modelled. In particular, the peculiarity of channel bed instabilities and shallows landslides are treated differently and different approaches are taken to determine the thresholds for the triggering of the two phenomena.

To account for the uncertainty related to natural variability in the factors influencing the stability of natural slopes, the safety factor is computed with a probabilistic approach, in order to determine the likelihood of slope failures, assigning to soil parameters distributions instead of single deterministic values.

This analysis has been carried out on a selected alpine watershed, located in the Trentino region, for which some geological and geotechnical data were available. Recently this watershed has experienced landslides and debris flows during intense storms following long and moderate intensity rainfall events. The distributed coupled GEOtop-SF model has been calibrated by reproducing some of these events and validated in order to forecast future failure probabilities.